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Niederschlagsbeobachtungen an den meteorologischen Stationen. 1908. 8. Jahrg. Darmstadt. 1909. 51 p. f°.

Imperial Russian geographical society.
Otchet. 1908. St. Petersburg. 78 (217) p. 8°.

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Grönlands Klima. (Atlanten. [Kobenhavn.] 4. Aargang. Maj–Juli 1907. p. 331–347.)

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Result of the meteorological observations made at the Japanese meteorological stations in... Korea. 1906. Tokio. f°.

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Annual report... 1908. Madras. 1909. 26 p. f°.

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11er Bericht. (Abdruck aus den Berichten der mathematisch-physischen Klasse der K. sächsischen Gesellschaft der Wissenschaften zu Leipzig. p. 61–91. 8°.)

Loisel, Julien.
Recherches sur les relations des phénomènes solaires avec la quantité de chaleur reçue à la surface du sol; 2. Variation annuelle de la quantité de chaleur que nous envoie le soleil; 3. Quantité de chaleur reçue dans le cours de l'année. Paris. 1908. 64 p. 8°. (Thèse–Faculté des sciences de Paris.)

Mainka, C.
Einfache Erdbebenapparate. (Sonder-Abdruck aus "Der Mechaniker," no. 6 (1909).

Massany, Ernö.
A légköri nedvesség meghatározásának különbözö módjai különös tekintettel a párateltség hiányára. Budapest. 1906. 40 p. 8°.

Meyer, Rudolf.
Meteorologische Optik. (Sonderabdruck aus "Adolf Richter's Kalender auf 1909." p. 235–272.)

Physikalischer Verein zu Frankfurt am Main.
Jahresbericht. 1907–1908. Frankfurt am Main. 1909. 124 p. 8°.

Podolia (Russia). Station expérimentale agronomique de Ploty.
Observations météorologiques 1907. Odessa. 1908. 60 p. 4°.

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Bericht über die Tätigkeit des Königlich preussischen meteorologischen Instituts, 1908. Berlin. 1909. 97 p. 4°.
... Untersuchungen über die Schwankungen der Niederschläge. Berlin. 1909. 81, xxviii p. f°. (Abhandlungen Bd. 3. Nr. 1.)

Salvator, Ludwig.
Warum die Nordseite der Mittelmeerinseln die mildere ist. (Separatabdruck aus Mitt. d. K. k. geogr. Gesellschaft in Wien. 1908. Heft. 5 u. 6. 7 p.)

Schubert, Johannes.
Die jährlichen Temperaturextreme zu Eberswalde und Berlin in den 25 Jahren 1884 bis 1908. Eberswalde. 1909. 14 p. 8°.
Die Niederschlag in der Annaburger Heide 1901–1905. (Sonderabdruck aus der "Zeitschrift für Forst- und Jagdwesen," 1908, Heft 10. 14 p. 8°.)
Ueber einige neuere Methoden und Ergebnisse der physikalischen Erdbebenforschung. Eberswalde. 1909. 5 p. 8°.
Die Witterung in Eberswalde im Jahre 1907. Mit einer Untersuchung über die Niederschlag, Abfluss, Verdunstung und Bodenfeuchtigkeit. (Sonderabdruck aus der "Zeitschrift für Forst- und Jagdwesen," 1908, Heft 12. 10 p.)

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17er Jahres-bericht. 1908. Wien. 1909. 54 p. 4°.

Stonyhurst college observatory.
Results of meteorological and magnetical observations, 1908. Liverpool. 1909. xvii, 70 p. 12°.

Turin. Universita. Osservatorio.
Osservazioni meteorologiche. 1907. Torino. 1908. 53 p. 8°.

Upsala. Université. Observatoire météorologique.
Bulletin mensuel. v. 40. 1908. Upsala. 1908–1909. 74 p. f°.

AN ANNOTATED BIBLIOGRAPHY OF EVAPORATION.

By MRS. GRACE J. LIVINGSTON. Dated Washington, D. C., January 8, 1908.

[*Continued from the Monthly Weather Review, February, 1909.*]

1879.

Alexandre, F.
Note relative à la mesure de l'évaporation de l'eau. Congrès de mét., Expos. univ. int. de Paris, 1878, Compt. rend. sténog., no. 20: 207–16. 1879. Also Paris. 1881. 12 p. 8vo.

Describes experiments carried on at Angoulême with a rectangular sheet iron evaporator 1.5 meters by 1 meter by 40 centimeters, with cement bottom and an outlet. The difficulty of reading, owing to small oscillations of the water surface, was obviated by floating in the large tank a smaller basin, 225 millimeters in diameter, the level of the water in which was observed to tenths of a millimeter by means of a sheet iron float which actuated a pointer. Corrections were made for the influence of heat on the walls of the apparatus and on the water. Tables of other meteorological observations accompany those of evaporation. The maximum daily evaporation for the summer, 9 millimeters, occurred on August 1 with the maximum temperature of the air, 34° C., and of the water, 31° C.

Beaudrimont, A.
Evaporation de l'eau sous l'influence de la radiation solaire ayant traversé des verres colorés. Compt. rend., 1879, **89**:41–3; and Monit. sci., 1879, **21**:1076–80. Abstract in Ciel et Terre, 1881, **1**: 404–5.

Observations of the variation in rate of evaporation of water under the influence of solar radiation through different colored glass. Yellow and colorless glass produced the most evaporation, red the least. (See Marié-Davy, 1878, 2d title.)

Borius.
De l'identité des résultats fournis au Sénégal par l'observation de l'évaporomètre de Piche et du papier ozonométrique de Jame (de Sedan). Congrès de mét., Expos. univ. int. de Paris, 1878, Comp. rend. sténog., no. 20:187–8. 1879.

Curves of the evaporation as measured by the Piche evaporometer, and of the ozone of the atmosphere as indicated by ozone-paper, when drawn with zero points in opposition continued almost exactly identical for thirty months. In spite of detected uncertainties in the ozonometric method the author considers it very interesting to ascertain that both physical and chemical methods furnish identical results. He considers that the value of the Piche instrument as a means of research remains to be determined, and that it does not lie in its use as an evaporometer.

Cantoni, Giovanni.
Sulle condizioni di forma e di esposizione pui opportune per gli evaporimetri. Rend. r. ist. Lomb., 1879, **12** (ser. 2): 941–6. Reviewed in Riv. sci. ind., 1880, **12**: 49. Abstract in Zeits. Oest. Ges. Met., 1881, **16**: 39–40.

Describes a modification of the Piche evaporometer, designed to remove difficulties arising from hydrostatic pressure. It is pointed out that evaporation depends not only on temperature, humidity, and area of the evaporating surface, but also on the amount of water in the dish, on the mass and thermal conductivity of the material of the dish, on the ratio between the mass of water and the surface of the dish, on the ratio between the diameter and the depth of the liquid, and on the movement of air about the dish.

Cantoni, G.
Sugli evaporometri e sulla temperatura dell'aria. Ann. uffic. cent. met. Ital., 1879, 1(ser. 2): 47–59.

Emphasizes the importance of exposure of the evaporometer.

Cantoni, G.
Quels progrès ont fait les méthodes pour la détermination de l'évaporation? Rap. deux. congrès mét. int. de Rome, 1879: 123–4.

Distinguishes between observations of evaporation for meteorological and for agricultural purposes; and, in the former case, advises the dimensions of the atmometer be reduced to the utmost, since the difference between the temperature of the air and that of the water increases as the mass of the water in the basin and in the whole apparatus increases.

Ebermayer, E.
Bericht über die Fragen 18 (Bestimmung der Bodentemperatur), und 21 (Verdunstungsbeobachtungen), des Programme für den Meteorologen Congress in Rom. Leipsic. 1879. 8vo. Also Rap. deux. congrès mét. int. de Rome, 1879: 87–9, 91–5.

Groups instruments for measuring the evaporation of water into two classes: (1) those for scientific researches, e. g., Osnaghi's (1874), Morgenstern's, and Hough's (1874) recording; and (2) those for practical studies. The latter class should be exposed to a variety of climates.
Describes Morgenstern's instrument as consisting of a moist paper 10 centimeters by 10 centimeters, stretched on a frame and absorbing water by capillarity from a burette placed below it. This is apparently not the same form described by Symons, 1876.
Recommends form, construction, and manipulation of instruments.

Höhnel, Franz.
Ueber die Transpirationsgrössen der forstlichen Holzgewächse mit Beziehung auf die forstlich-meteorologischen Verhältnisse. Zeits. Oest. Ges. Met., 1879, **14**:286–91.

An experiment conducted from June to November compared water loss from fifteen different kinds of young trees replanted in air-tight pots, and it was found that birch lost most and black fir least. The amount of water loss was compared with the rainfall for the period.

Modena, Reale Osservatorio.
Osservazioni sulla evaporazione. Ann. soc. met. ital., 1879, **2**.

Mohn, H.
Grundzüge der Meteorologie. Berlin. 1875. 2d ed.
See Mohn, 1875.

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Sun spots and the Nile. Nature, 1879, **19**:299.

Points out a coincidence between frequency of sun spots, increased rainfall, and increased evaporation.

Ragona, D.
Esperienze sulla evaporazione. Ann. soc. met. ital., 1879, **2**.

Ragona, D.
Évaporomètre enregistreur. Congrès de mét., Expos. univ. int. de Paris, 1878, Compt. rend. sténog., no. 20:25. 1879.

A balanced evaporating dish rises as its weight diminishes by evaporation, drawing with it a marking pointer which moves in front of but without touching a revolving cylinder. Every quarter of an hour a hammer, actuated by a clock movement, presses the pointer against the cylinder and registers the distortion of the balance, and hence the amount of evaporation.

Riegler, Wahrmund.
Das evaporimeter "Piche" und seine Angaben in Beziehung zur Verdampfung freier Wasserflächen. Zeits. Oest. Ges. Met., 1879, **14**:368–74. Abstract in Forsch. Geb. Agr. Phys., 1880, **3**:111–2.

The evaporation from a free water surface is to that from a Piche evaporometer as 1:2.08. Discusses the defects and advantages of the Piche instrument.

Russell, H. C.

Meteorology of New South Wales. Results of rain and river observations made in New South Wales. Sydney. 1879.

The series appeared under various titles, as follows: 1878, Results of rain observations made in New South Wales; 1879–88, Results of rain and river observations... (1886 included observations in Queensland); 1889–94, Results of rain, river, and evaporation observations... All these reports contain results of observations of evaporation. See Symons, 1890, for amount of evaporation which Russell has found possible at Sydney and other stations in New South Wales.

Skinner, J. D.

Table of daily evaporation at the sources of the Mississippi River, autumn 1878. Rpt. Chf. Eng., 1879, pt. 2:1226–7.

The rate of evaporation from a freely exposed pan of water was shown to be nearly twice as great as that from a pan in the shade or from one set in a marsh.

Symons, G. J.

[Address by, before the Sanitary Institute at Croyden.] Symons's met. mag., 1879, **14**:164.

"Hygrometry is almost identical with the measurement of evaporation, but not quite, because hygrometry considers the amount of moisture in the air at rest, and evaporation is the resultant of the average of a variable number of miles of air of a variable hygrometric condition over a water surface."

Todd, Charles.

Meteorological observations made at the Adelaide Observatory during the year 1878. Adelaide. 1879. Review in Symons's met. mag., 1880, **15**:72–4.

The reviewer believes there is no European observatory where such judicious arrangements for measuring evaporation are in operation as these at Adelaide. One evaporator consists of a zinc-lined wooden tank 4 by 4 by 3.5 feet, sunk 3 feet in the ground. It is filled with water nearly to the top, and the level of the water is observed by means of a vertical rod moved by rack and pinion and reading by vernier to 0.01 inch. A second instrument consists of a cubical slate tank, 3 feet on a side, placed in a larger cement-lined brick tank 4.5 by 4.5 by 3.25 feet. Both are filled with water to the same level. The evaporation from the inner tank is measured on a graduated vertical rod carried by a float. A table comparing the two instruments shows less evaporation from the slate tank than from the wooden one. In 1878 the total from the latter was 58.8 inches, from the former, 69.19 inches.

Volland.

Ueber Verdunstung und Insolation, ein Beitrag zur besseren Kenntniss des Hochgebirgsklimas. Basel. Switzerland. 1879. 34 p. 8 vo. Abstract in Fortsch. f. Met., 1879, **15**:102–2.

Observations made simultaneously at Davos, Switzerland, and Strassburg, Germany, of the evaporation of water from small vessels protected from sun and rain, but freely accessible to the air, show by weekly weighings that: (1) loss by evaporation is less on high mountains than on lowlands; (2) the rarer air and decreased atmospheric pressure of high altitudes has a lower capacity for water vapor, and thus retards evaporation; (3) insolation on mountain tops is lower in summer and higher in winter than on the lowlands, and for the same reason as in (2); (4) on mountain tops the air is driest in winter.

1880.

Croll, James.

Aqueous vapor in relation to perpetual snow. Amer. jour. sci., 1880, **20** (3d ser.): 103–5. Extract in Mo. weather rev., October, 1880, [**8**]:16.

Points out that snow evaporates even when the temperature is below the freezing point.

Ebermayer, E.

Beschreibung einer Methode zur Bestimmung der Durchlässigkeit und Verdunstungsgrösse der verschiedenen Bodenarten. Protokol der Int. Konf. für Agrarmet. Vienna. 1880.

Forster, A.

Ueber das Verhältniss der Angaben des Evaporimeter Piche zu denen des Wild'schen Waagevaporimeter. Jahrb. tellur. Obs. Bern. 1880. Also Forsch. Geb. Agr. Phys., 1881, **4**:466–8.

The rates of evaporation from the Piche and from the Wild evaporometers were compared from May, 1879, to October, 1880. The Piche instrument gave a rate per square centimeter of exposed surface, 1.99 to 2.22 times greater than that of the Wild instrument. (See Shaw, 1882.)

Haughton, Samuel.

Six lectures on Physical Geography. Dublin and London. 1880. p. 123.

Gives general estimates of evaporation.

Houzeau, J. C. and A. Lancaster.

Traité élementaire de météorologie. Paris. 1880. Review in Symons's met. mag., 1881, **16**:73–6.

Draws attention to the rôle played by evaporation as affecting sensible temperatures in polar regions or elsewhere under very low temperatures.

Kunze, M. F.

Das Evaporimeter "Piche" und seine Angaben in Beziehung zur Verdampfung freier Wasserflächen. Zeits. Oest. Ges. Met., 1880, **15**:21–2. Review in Forsch. Geb. Agr. Phys., 1881, **4**:468; Ciel et Terre, 1881, **1**:44–5.

Experiments similar to Riegler's, 1879, compare the rate of evaporation from a Piche evaporometer and from a free water surface, from October 20 to November 14, 1879. The ratios found, 1.05, 1.12, or 1.09, are much smaller than those found by Riegler. The two instruments agreed almost exactly during the night, but during the day the Piche instrument showed a higher rate, due probably to the heating of the high thin walls of the tube.

Lancaster, A.

See Houzeau, J. C., and A. Lancaster, 1880.

Lavel.

Recherches sur l'évaporation et sur les causes qui la modifient. Mém. soc. sci. phys. et nat. Bordeaux, 1880, **3**.

Lommel, E.

Wind und Wetter. Leipsic. 1880.

Describes Prestel's (1864) atmometer on p. 49.

Masure, Félix.

Recherches sur l'évaporation de l'eau libre, de l'eau contenue dans les terres arables, et sur la transpiration des plantes. Ann. agron., 1880, **6**:441–500. Abstracts in Forsch. Geb. Agr. Phys., 1880, **4**:135–8; Symons's met. mag., 1881, **16**:67–8.

Describes measurements at Orléans, of the rate of evaporation from water, soil, and vegetation, from August 6, to November 15, accompanied by observations of the temperatures of the air and water, the relative humidity, etc. Derives the following expression for evaporation:

$$h = K\frac{F_{t'}}{H}\ (F_{t'} - UF_t).$$

where h = millimeters of water evaporated in six hours, t = mean temperature of the air for the six hours, t' = mean temperature of the water, F_t = maximum vapor pressure at the temperature of the air, $F_{t'}$ = maximum vapor pressure at the temperature of the water, U = mean relative humidity, H = barometric pressure, K = constant depending on such secondary factors as solar radiation, the weather, the wind, the electrical and chemical state of the air, etc. A table compares the rates of evaporation from soil under different conditions of moisture, and from free water surfaces, shows that wet soil evaporates more and a dry soil *less* than a free water surface. The transpiration of plants is regarded as a complex phenomenon. The average daily evaporation from a water surface at Orléans, during the period studied, was 163.8 millimeters, 48.02 millimeters in the forenoon, 101.32 millimeters in the afternoon, and 14.46 millimeters during the night.

Stelling, Ed.

Ueber den jährlichen Gang der Verdunstung in Russland. Repert. f. Met., 1880, **7**, No. 6: 1–75. Also (with a plate of curves) St. Petersburg. 1880. 4to. Abstracts in Zeits. Oest. Ges. Met., 1881, **16**:117–9; Forsch. Geb. Agr. Phys., 1881, **4**: 132–5; Fortsch. f. Met., 1881, **7**: 75–80.

A study of evaporation at 23 stations in Russia, with Wild's evaporometer, from 1872, shows the minimum to occur generally in January and the maximum in July. The form of the curve is determined by relative humidity and temperature. Weilenmann's formula is quoted as showing a methematical relation between these elements and evaporation. The expression $V = a(G - g)$, in which a = a constant, G = the weight of the water vapor per unit volume of saturated air at the given temperature, and g = the actual weight of the water vapor per unit volume, may also be written $V = aG\left(1 - \frac{g}{G}\right)$. It is shown that $\frac{g}{G}$ = the relative humidity, r, therefore if r is expressed in per cent, the equation becomes $V = a'G\ (100 - r)$. G, a function of the temperature, increases in geometrical progression as the temperature increases in arithmetical progression. This equation suggests: (1) At constant temperature the evaporation is inversely proportional to the relative humidity; (2) the influence of the relative humidity on the absolute amount of increase or decrease of evaporation is greater at high temperatures than at lower. Observations of rainfall and other meteorological elements are given, and curves present evaporation rates for eleven stations.

Wollny, E.

Untersuchungen über den Einfluss der oberflächlichen Abtrocknung des Bodens auf dessen Temperatur- und Feuchtigkeitsverhältnisse. Forsch. Geb. Agr. Phys., 1880, **3**: 325-48.

Shows that a dry surface layer to a great degree retards evaporation from the soil.

1881.

Blanford, H. F.

Description of a rain gauge with evaporometer, for remote and secluded stations. Jour. Asiat. soc. Bengal, 1881, **50** (pt. 2): 83-5. Also Proc. Asiat. soc. Bengal, 1881, (-): 76-7.

Fornioni, G.

Di un evaporimetro a livello costante. Rend. r. ist. Lomb., 1881, **14**: 356-9.

The instrument consists of an evaporating dish connected with a supply reservoir by a glass tube. A spring raises the reservoir as the water is consumed, thus keeping the water in the evaporating dish at a constant level. The movement of the reservoir is transmitted by means of a thread and pulley to the pointer of a dial which indicates the amount evaporated.

Forster, A.

Ueber den täglichen und jährlichen Gang der Verdunstung in Bern. Jahrb. tellur. Obs. Bern, 1881, (—):5–7. Abstract in Forsch. Geb. Agr. Phys., 1881, **4**:465–6.

Observations were made twice daily of the rate of evaporation from a Wild evaporometer exposed in a thermometer shelter, from March, 1878, to December, 1880. The maximum daily amount for this period, 49 millimeters, occurred in July, 1880, and the minimum, 2.5 millimeters, in December, 1879.

Garban.

On the rate of evaporation. Paper read at the Réunion annuelle des sociétés savantes in Paris in 1881. Abstract in Symons's met. mag., 1881, **16**: 66.

According to Ramsay (1884), Garban's experiments on the rate of evaporation from various soils showed a lower rate from chalk than from sand, the latter appearing to collect most dew and vapor and to yield its vapor more readily than any other variety of soil.

Gilbert, J. H.

See Lawes, J. B.

Gugliemo, G.

Sulla evaporazione dell' acqua e sull' assorbimento del vapore acqueo per effetto delle soluzioni saline. Turin. 1881. 8vo. 21 p.

Kunze, M. F.

Das Evaporimeter "Piche" und seine Angaben in Beziehung zur Verdampfung freier Wasserflächen. Zeits. Oest. Ges. Met., 1881, **16**:30–1.

The experiments described in Kunze's paper of 1880 were continued from April to October, 1830. They give 0.670 as the ratio of evaporation from a free water surface to that from the Piche instrument for April, and 0.782 for July.

Lawes, J. B., J. H. Gilbert, and R. Warington.
On the amount and composition of the rain and drainage waters collected at Rothamsted. Parts I and II. Jour. roy. agr. soc., 1881, 17 (ser. 2): 241-79, 311-50.

Description of the elaborate means employed at Rothamsted to isolate in its natural condition a plot of soil. A table of rainfall, drainage, and evaporation for the period 1870-80 shows the annual evaporation ranging from 14.279 to 19.686 inches. Finds that the average evaporation from soil bare of vegetation, in a climate having a mean temperature of 48° F., will be nearly 12 inches during the six summer months, about 5.5 inches during the six winter months, and 17 to 18 inches for the whole year. Discusses the results obtained by others along this line, describes the form of Dalton's percolation gage, as used by Maurice, Gasparin, Dickinson and Evans, Greaves, Ebermayer, Sturtevant, etc. In all these cases the soil was too loose to approximate the natural conditions and grass was allowed to grow, thus increasing the evaporation. Gives Graves's [Greaves'?] results from a similar experiment with a mass of pure sand, showing the average drainage and evaporation for the fourteen years, 1860-73.

Ragona, D.
Andamento diurno e annuale della evaporazione. Mem. reg. accad. sci. Modena, 1881, 1, (ser. 2). Also Modena. 1881. 28 p. 4to. Reviewed in Zeits. Oest. Ges. Met., 1882, 17: 242-3; Ann. soc. mét., 1882, 30: 35-7.

The reviewer doubts Ragona's statement that there is no daily periodicity in the rate of evaporation as shown by his self-recording evaporometer (see Ragona, 1879); also that the winter months show a negative evaporation. These apparently incorrect observations are attributed to the method used.

Russell, Henry Chamberlain.
Evaporation. Min. proc. intercol. met. conf. at Melbourne, April, 1881. Melbourne. 1881. 4to. p. 12-13.

Results of observations with three forms of evaporators, 1871-1880.

Shaw, W. N.
Report on hygrometers and evaporimeters, presented to the Meteorological Council May 10, 1881. Metl. council rpt., 1881, (—): 28-30.

Instruments of the same pattern as described in Shaw, 1877, are used in these experiments. The different forms gave the following widely divergent results:

Instruments.	Evaporation.
	Mm.
Lamont	3.88
de la Rue (1)	3.61
de la Rue (2)	3.16
Wild	2.85
Piche	97.3

Estimates that 20 millimeters of the Piche scale are equivalent to 1 millimeter of evaporation from a free water surface.

Stefan, J.
Ueber die Verdampfung aus einem kreisförmig oder elliptisch begrenzten Becken. Sitzber. k. Akad. Wiss. (Vienna), math. naturw. Kl., 1881, 83 (pt. 2): 943. Abstract in Zeits. Oest. Ges. Met., 1882, 17: 63-8.

A study of the laws of evaporation from circular and elliptical vessels brings out the facts that, whereas one would expect a much higher rate of evaporation from an elliptical surface than from a circular one of equal area, this is only the case for those ellipses whose major axis is many times greater than the minor one. Otherwise the evaporation from an elliptical surface is but little greater than from a circular one. The evaporation from a large water surface is relatively less than that from a small one, because the amount of evaporation is not proportional to the area but to the square root of the area.

Stefan, J. and Maxwell, [J. C.]
Theorie des Psychrometers. Zeits. Oest. Ges. Met., 1881, 16: 177-82.

Mathematical discussion of the laws of psychrometry. German translation of J. C. Maxwell's article, "Theory of the wet-bulb thermometer," Encyc. Brit., 9th ed., vol. 7, p. 218-, article "Diffusion." Edinburgh. 1877.

Stelling, Ed.
Ueber die Bestimmung der absoluten Grösse der Verdunstung von einer freien Wasserfläche nach den Beobachtungen im Observatorium in Pawlowsk. Repert. f. Met., 1881, 8, (Kl. Mitt. No. 2): 10-9. Review in Zeits. Oest. Ges. Met., 1882, 17: 373. Ciel et Terre, 1883, 3: 214.

Wild, at Pavlovsk in the summer of 1878, found that the temperature in his floating evaporometer was sometimes as much as 10° C. higher than that of the water in the pond. In 1880 the apparatus was altered so that the two temperatures agreed very closely. Calculations by the Dalton-Weilenmann formula (Weilenmann, 1877) showed that the indications of the evaporometer could then, with hardly any correction, be taken as the evaporation from the free surface of the pond. The formula is $v = A\Sigma(S-s) + B\Sigma(S-s)w$. A and B are constants under general conditions, v = the rate of evaporation, S = the vapor pressure at saturation at the temperature of the water, s = the vapor pressure at the dew-point, and w = wind velocity in meters per second. Describes his floating instrument.

Symons, G. J.
A contribution to the history of hygrometers, (read March 16, 1881). Quart. jour. roy. met. soc., 1881, 7 (n. s.): 161-185.

Gives a chronological list from 1644 to 1879 of the inventors of hygrometers, with a brief description of each instrument. Also an alphabetical list of the same with bibliographic references.

Symons, G. J.
Evaporation. Brit. rainf., 1881, (—): 46.

A general discussion of the influence of the size of the evaporator on the rate of evaporation, and of the necessity of using large evaporating surfaces to secure results comparable with the actual evaporation from large natural bodies of water. Gives the recommendations of the Agricultural Congress at Vienna in 1880 regarding study of evaporation.

Violi, A.
Sull' evaporazione dell' acqua. Rend. r. ist. Lomb., 1881, 14: 576-80.

The influence of the area of the evaporating surface upon the rate of evaporation is considered subordinate to that of the temperature and relative humidity.

Warington, R.
See Lawes, J. B., etc.

Wollny, E.
Bericht über die Verhandlungen und Ergebnisse der internationalen Conferenz für land- und forstwirthschaftliche Meteorologie, abgehalten in Wien in den Tagen vom 6-9, September, 1880. (Aus den Sitzungsprotokollen zusammengestellt und mit Bemerkungen versehen.) Forsch. Geb. Agr. Phys., 1881, 4: 276-305. Translated in Quart. jour. roy. met. soc., 1881, 7: 117-20.

[Wollny, E.]
Resolutions adopted by the Conference for the development of Agriculture and Forest Meteorology, held at Vienna in September, 1880. Quart. jour. roy. met. soc., 1881, 7: 117-20.

"The Conference is of the opinion that observations of evaporation are important, but that no existing instrument can be proposed for general and exclusive use. In fact it is recognized as an immediate requirement to devise satisfactory instruments and especially such as would admit of the accurate measurement not only from free water surfaces but also from different soils in the fallow and cropped states. Meanwhile, observations on evaporation should not be neglected, but they should be conducted with simple forms of apparatus, especially those depending on weight, as well as with the Piche atmometer modified according to the suggestions of Professor Cantoni." (See Cantoni, 1879.)

1882.

Carl, Philipp.
Ein einfacher Verdunstungsmesser. Repert. der Phys., 1882, 18: 630-1.

An evaporating vessel is laterally connected by a rubber tube with a graduated glass cylinder, which can be raised and lowered. The zero point of the scale is brought to the same level as the opening from the evaporating dish into the connecting tube. Water is poured into the apparatus until it stands at this level. The graduated cylinder is then raised so that water rises and fills the evaporating dish. At the end of a definite period the fall of the water level in the graduated vessel can be directly observed.

——— L' évaporation. Ciel et Terre, 1882, 3: 91-2.

Discusses the questions raised by Tacchini, de Lesseps, and Symons, regarding the necessity of large evaporating vessels for approximating natural conditions. Concludes that the rate of evaporation increases in proportion as the size of the evaporometer employed diminishes.

Cunningham, Allan.
Recent hydraulic experiments. Proc. inst. civ. engin., 1882, 7: 1-36.

Measurements of evaporation were made on the Ganges canal near Roorkee in northern India for 25 months, during 1876-9. The evaporator was a zinc pan, 12 by 12 by 9 inches, resting in a wooden frame and buoyed by air chambers so as to float on the surface of the canal. The observed rate of evaporation was remarkably low, the average being only 0.10 inch per day; whereas 0.50 inch per day is said to be a common rate for Indian land exposures. The cause of the low rate appears to be the extreme coldness of the canal water which is from the snow-fed Ganges. On May 22, 1877, at 2:30 p. m., the air temperature was 165° F. in the sun, and 105° in the shade, while the water was only 66° inside the pan and 65° in the canal. The highest recorded temperature of the canal water was only 75.5° F. The total evaporation from the whole surface of the canal and its branches was estimated at about 47 cubic feet per second, about 1/150 of the full supply of the canal or the entire supply for ten minutes daily.

Decaudin-Labesse.
Marche diurne et annuelle de l'évaporation, par le Prof. D. Ragona, directeur de l'Observatoire de Modène. Ann. soc. mét., 1882, 30: 35-7.

Many variations but no certain periodicity, are shown in Ragona's curve of daily evaporation (see Ragona, 1881.) The influence of wind on evaporation is shown to be such that "if all other instruments were lacking, the self-recording evaporometer would suffice to indicate strong gusts of wind, even when the evaporometer is sheltered." Ragona's formula is $E=0.18259\,T-0.01823\,U+0.15145\,F$, where T=temperature, U=relative humidity, F=the velocity of wind in kilometers per hour. The reviewer expresses surprise at evidences of "negative evaporation." The differences between the temperatures of the air and dew-point are tabulated, showing that this difference is very small in winter when "negative evaporation" often occurs. The rate in a closed sunless place seems to be governed by the same laws as those for an open sunny place. The maxima and minima for the year follow those of the temperature. The total annual evaporation at Modena is determined as 2223.10 millimeters.

Dewar, D.
A new theory of Nature; containing observations on weather, tides, capillary attraction, evaporation, and sun-spots. London. 1882.

In experiments with evaporation from water in capillary tubes, it was shown that in vessels having surfaces and bases of equal areas, the smaller the free surface and the less the height of the liquid the greater is the evaporation.

Freeman, S. H.
On the question of electrification by evaporation. Phil. mag., 1882, 13 (5): 398-406. Notice in Ciel et Terre, 1883, 4: 287-8.

The theory that evaporation is the source of atmospheric electricity, first proposed by Volta and upheld more or less by Pouillet, Tait, and Wanklyn, is here controverted. "If the charges of electricity produced in experiments with evaporation are really due to evaporation (and not to friction and leakage, as is more probable), and if evaporation is the principal source of atmospheric electricity, the calculations of the amount of evaporation necessary to produce one flash of lightning show that a much greater quantity of water would be required than is ever found in a thundercloud." Further the total annual evaporation from the earth will not account for the annual number of lightning flashes usually observable from any one place.

Langer, Th.
Vergleichende Beobachtungen mit dem Evaporimeter Piche unter vielerlei Exposition. Forsch. Geb. Agr. Phys., 1882, 5: 105. Abstract in Zeits. Oest. Ges. Met., 1882, 17: 375.

Experiments comparing the rate of evaporation from four Piche atmometers in different exposures, were conducted during the summer months of 1880, accompanied by observations on the temperature of each, the cloudiness, relative humidity, pressure, and wind velocity. The rate increased with the degree of exposure. The Piche, and particularly the form as modified by Cantoni (1879), is recommended for the purposes of agricultural meteorology.

Latham, B.

Experiments with Greaves's floating evaporator. Proc. inst. civ. engin., 1882, 71:47. (In the discussion following the paper by Cunningham, 1882.)

For a general description of this apparatus see Symons, 1869. In these experiments the author brings out the fact that too high evaporation rate may be produced by the capillary action of the water on the sides of the vessel. From a number of evaporators painted different colors the rate was always higher, even from the black, than from the plain copper, because the painted surfaces induced greater capillary action than metal. Further experiments show the influence of the size of the vessel, the larger the vessel in proportion to the surface exposed to evaporation, the smaller is the marginal ring up which the water passes by capillarity and the less is the evaporation rate.

Robie, David.

Rain and Dalton gages. A letter to the Editor. Symons's met. mag., 1882, 17:184-6.

Experiments with the Dalton gage at Bedford, England, showed that in 1882 almost half the 28.42 inches of rainfall was evaporated. The monthly percentages of this amount that percolated into the soil were as follows: January, 63; February, 50; March, 68; April, 48; May, 54; June, 20; July, 51; August, 8; September, 40; October, 46; November, 67; December, 94. Dalton gages of various depths in operation at Rothamsted show that the moisture in the soil may be drawn up from considerable depths by evaporation, one gage being 5 feet deep.

Sresnevski, Boris.

Ueber die Verdampfung von Flüssigkeiten. Jour. Russ. phys. chem. soc., 1882, 14:420-69, 487-98. Abstract in Beibl. Ann. Phys. und Chem., 1883, 7:888-90.

In the investigation of an atmometer constructed by Petrushevski, which allows evaporation not from a flat surface but from the curved surface of a drop segment (Tropfensegmente), it developed that the amount of evaporation is proportional to the circumference of the segment and not to the surface. This confirms the conclusion reached theoretically by Stefan in 1881, that the amount of liquid evaporation from a circular hole in a flat surface should be proportional to the circumference of the hole.

Stelling, Ed.

Ueber die Abhängigkeit der Verdunstung des Wassers von seiner Temperatur und von der Feuchtigkeit und Bewegung der Luft. St. Petersburg. 1882. 42 p. 4to. Also Repert. f. Met., 1882, 8: No. 3. Abstract in Zeits. Oest. Ges. Met., 1882, 17:372-3.

Observations of the evaporation (by a Wild evaporometer) and other meteorological elements were made every two hours at Nukuss from May to September, 1875. He uses the Dalton-Weilenmann formula [see Stelling, 1881], $dv = A(S-s)\,dz + B(S-s)\,w dz$, in which dv = the evaporation in millimeters for the time dz, S = the vapor pressure of saturated air at the temperature of the evaporating water, s = the actual vapor pressure of the air in millimeters of mercury, w = the wind velocity in kilometers per hour, and A and B are constants evaluated from the observed evaporation depth. Concludes that the Dalton-Weilenmann formula is reliable to within ± 10 per cent of the actual depth of evaporation in the open and to within ± 15 per cent of that depth under a shelter.

van Tricht, P. Victor.

Évaporomètre à plongeur. Ciel et Terre, 1882, 3:430-2.

Describes in detail the design of an evaporometer of the Lamont (1868) type.

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Verdunstungsmesser in Pawlowsk. Zeits. Oest. Ges. Met., 1882, 17: 367-8.

Describes and illustrates the floating evaporometer devised by Wild and described by Stelling, 1881.

Wiedemann, Gustav.

Die Lehre von der Electricität. Braunschweig. 1882. 5 vol.

In 1: 240-1 and 4: 628-9, there is a general discussion of the generation of electricity by evaporation, and of the influence of electrification on evaporation.

1883.

Blake, Lucien.

On the production of electricity by evaporation, and on the electrical neutrality of vapor arising from electrified still surfaces of liquids. Phil. mag., 1883, 16(5): 211-24. Reviewed in Ann. Phys. und Chem., 1883, No. 7; Zeits. Oest. Ges. Met., 1882, 17:482; Ciel et Terre, 1883, 4: 311-12.

Two different methods of experimentation lead to the conclusion that "the charge [produced by evaporation from sea-water] is too small in proportion to the sea-water evaporated, to be used as a basis for mathematical calculations concerning the electricity resident in the clouds [see Freeman, 1882]. Nor is it a sufficient ground for the assertion that the simple change of a liquid into a vapor produces electricity." Other experiments seem to show that "the vapor arising from electrified still surfaces of liquids is electrically neutral."

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L'eau tombée et l'évaporation à la surface de la terre. Ciel et Terre, 1883, 4: 18-20.

Abstract of John Murray's estimates of evaporation from rainfall and run-off.

Dieulafait.

Évaporation de l'eau de mer dans le sud de France et en particulier dans la delta du Rhône. Compt. rend., 1883, 96: 1787-90.

From experiments on the French Mediterranean coast in the region of the delta of the Rhone, it is concluded that the average daily evaporation from sea-water, even at some distance out from land, is at least 6 millimeters.

Dieulafait.

Évaporation des eaux marines et des eaux douces, dans la delta du Rhône et à Constantine. Compt. rend., 1883, 97: 500-2.

The ratio between the evaporation of salt water and fresh, stated by Roudaire as 62:100 is believed to be inexact. The ratio found by the weighing method was not lower than 96.5:100, and it is shown that theoretically this ratio is not less than 98:100 for normal sea water. Observations conducted by Pelletreau at Constantine show an average daily evaporation of 8 millimeters from May 1 to December 1, 1881. The daily average for the year is calculated as 6.6 millimeters or 6.3 millimeters from sea water.

Lalanne.

[Note on a paper by Salles.] Compt. rend., 1883, 97:349-50.

In connection with Roudaire's plan of an inland sea, the experiments of Salles, 1883, are mentioned as showing that evaporation is not so great from large bodies of water as observations of evaporation from small instruments seem to indicate.

Latham, B.

Evaporation from irrigated rye grass at Croydon. Proc. inst. civ. engin., 1883, 73:238.

In discussing O'Meara, 1883, the author cites experiments on the rate of evaporation from an artificially isolated plot of irrigated rye grass, showing a loss by evaporation of 183.3 inches from June 18, 1870, to June 12, 1871, while the rainfall for that period was 20.03 inches.

O'Meara, Patrick.

The introduction of irrigation into new countries, as illustrated in northeast Colorado. Proc. inst. civ. engin., 1883, 73:178-212.

Discussion of problems arising in an investigation of irrigation possibilities, such as evaporation from soil, evaporation of snow, and evaporation from reservoirs.

Ragona, D.

Andamento diurno e annuale della evaporazione. Mem. reg. accad. sci. Modena, 1883, 1 (ser. 2):145-70.

This article is mainly occupied with errors and corrections of the formula developed in Ragona, 1881 (see Decaudin-Labesse, 1882). The effect of wind on evaporation is illustrated by a typical daily curve.

Salles, A.

Expériences sur l'évaporation faites à Arles pendant l'années 1876 à 1882. Comp. rend., 1883, 97:347-9.

Observations of the evaporation from water in three masonry tanks 3 meters square, with the surface of the water at various levels. Special instruments were designed for accurate measurements. The average annual evaporation was 1.050 meters. A Piche atmometer gave 2.200 meters. Previous observations by Gasparin at Orange (sixteen years) gave 1.876 meters; by Cotte at Cavaillon (two years), 2.192 meters; by Cotte at Arles (five years), 2.563 meters, and by Valles at Marseilles, 2.350 meters. The Ingénieurs de ponts et chaussées at Dijon found 0.594 meter from large basins of masonry.

Sresnevski, Boris.

Ueber die Verdampfung von Flüssigkeiten. Jour. Russ. phys. chem. soc., 1883, 15:1-9.

Concludes his paper of 1882.

Tromelin, G. le Goarant de.

La grêle, les trombes, l'électricité atmosphèrique. Rev. sci., 1883, pt. 1 (—):779-85. Translated in Phil. mag., 1884, 17 (5):245-7.

Believes that atmospheric electricity results from the friction present in wind-caused evaporation; but does not believe quiet evaporation can produce electricity in unchanged air.

1884.

Abbe, Cleveland.

Progress in meteorology in the year 1883. Ann. rept. Smithsn. inst. for 1883. Washington. 1884. p. 27, 43, 65.

Summarizes Stefan's (1881) investigations, discusses the relation of evaporation to electricity according to Blake (1883), describes the Stelling and Wild evaporometer, (see Stelling. 1881), and reviews Langer's (1882) results with a Piche instrument.

Acireale, Osservatorio Meteorologico Pennisi.

Riassunto delle osservazioni meteorologische 1882-3. Acireale. 1884.

A table of humidity, evaporation, and rainfall for 1882-3 gives totals by decades and months. The total observed annual evaporation was 1694.2 millimeters and the rainfall 967.5 millimeters.

Decaudin-Labesse.

See H. Mohn, 1884.

Descroix, Léon.

Sur l'exagération du pouvoir évaporant de l'air à l'équinoxe du printemps. Compt. rend., 1884, 98:1352-5. Abstract in Ann. soc. mét., 1884, 32:209.

From observations with a Piche evaporometer it is concluded that "general vaporization of pure water at the surface of the paper varies as the ratio between the square of the number which measures the lowering of the dew-point on one side and the atmospheric temperature on the other." The author notes an increase in the evaporating power of the air in the spring, also the fact that evaporation under widely different temperatures, (11° C., afternoon in spring, 22° C. in midsummer), may be absolutely the same, although the relative humidity is not lower in April than in July. A table gives the comparative range of evaporation and related meteorological phenomena from 1873-84.

Eser, Carl.

Untersuchungen über den Einfluss der physikalischen und chemischen Eigenschaften des Bodens auf dessen Verdunstungsvermögen. Forsch. Geb. Agr. Phys., 1884, 7:1-124. Review in Met. Zeits., 1885, 2:430-2. Abstract in Fortsch. f. Met., 1885, 11:37-41.

Includes critical reviews of the work of Schübler, Meister, Wolff, Nessler, Hellriegel, Haberlandt, Johnson, etc., on transpiration and evaporation from soil. From the author's own experiments it is concluded: (1) Evaporation depends mainly on the amount of water in the soil; all soils evaporate equally when saturated. (2) The evaporating surface is at the surface until the saturation of the soil is less than 50 per cent when the evaporating surface sinks. (3) Evaporation depends on the porosity of the upper layers and is decreased by the drying of the surface. (4) Soils of a high rate of evaporation lose less water as they dry out than those having a lower rate. (5) Evaporation from a rough surface is greater than that from a smooth surface. (6) The physical structure and organic content of the soil are of primary importance because of the water capacity and capillarity; humus evaporates most, sand least, and clay is intermediate. (7) Evaporation is greater from the darker colored soil. (8) The soil covering is more important than the soil itself; plant-covered soil evaporates most, bare soil next, straw-covered land least. (9) Capillarity may cause salts to accumulate at the top. (10) Manures containing salts retard evaporation by increasing the salt content of the surface layer. (11) Inclined surfaces evaporate moisture at rates in the following order, south, east, west, and north. (12) Evaporation varies with the seasons. (13) Evaporation is in proportion to insolation.

Mohn, H.

Les phénomènes de l'atmosphère. Traduit par Decaudin-Labesse. Paris. 1884. p. 25, 105-12, 114, 129.

Discusses the rôle of water vapor in the movements of the atmosphere. Defines and states laws of evaporation and heat of vaporization. Describes and figures the Delahaye evaporometer. General discussion of the causes which determine the amount of evaporation. Figures for total annual evaporation given for different localities.

Ragona, D.
Andamente annuale della evaporazione. Ann. met. ital., Ser. II, 1884, **6** (pt. 1): 57–67. Also Rome. 1886. 16 p. 4to.

Devises a mathematical expression, employing the meteorological elements, by which the calculated evaporation agrees closely with the observed evaporation at Modena for five-day periods from 1879–1885. The instrument used was a simple cylindrical glass dish with a device for obtaining accurate readings of the level of the water.

Ramsay, Alexander.
A bibliography, guide, and index to climate. In the Scientific Roll and Magazine of Systematized Notes. London. 1884.

For evaporation see under Aqueous Vapor: Bibliography, 1682–1883 (incl.) and Notes, p. 177–449.

Symons, G. J.
Evaporation. Brit. Rainf., 1884, (—): 9.

Notice of the removal to Camden Square, early in 1883, of the large tank (Symons, 1870) which had been used for observing evaporation at Strathfield Turgiss.

Viñes, Benito.
Observaciones magneticas y meteorologicas del Real Colegio de Belen de la Compañia de Jesus de Habana, Ano de 1875. Habana. 1884. 4to.

Evaporation records for Habana, Cuba.

Wollny, E.
Untersuchungen über die Wassercapacität und das Verdunstungsvermögen verschiedener Streumaterialien. Forsch. Geb. Agr. Phys., 1884, **7**: 309–321.

Soil mulches, peat, loam, and sand, allow greater evaporation than mulches of dead plant parts. Among the last the moss mulch allows greater evaporation than one of needle leaves or of broad leaves, the latter being the most effective in retaining soil moisture.

1885.

Acireale, Osservatorio Meteorologico Pennisi.
Riassunto delle osservazioni meteorologiche, 1883–4. Acireale. 1885.

Table of evaporation, rainfall, and humidity for 1883–4. Total evaporation, 1686.1 millimeters, and rainfall, 942.3 millimeters.

Chabaneix, J.-B.
Évaporomètre du sol. Bul. mét. Hérault, 1885, (—): 79–86.

Describes a complicated arrangement for isolating soil in order to determine the rate of evaporation of its moisture. A zinc evaporating vessel, 30 by 30 by 30 centimeters, is filled with soil and buried in the ground. A spout from a gutter around the upper edge leads the excess of rainfall to a bottle. An underground reservoir supplies water by capillarity to the soil experimented with. Water is introduced into the reservoir, and thence to the whole apparatus, by a tube leading from the surface of the soil.

Guillemin, Amédée.
Le Monde Physique. Paris. 1885. 5 vol.

Descriptions are given of the Piche and the Delahay evaporometers, and a self-recording weighing apparatus, for determining evaporation from soils and plants. Tables of observations with the Piche instrument compare the rates of evaporation for day and night, also for summer and winter. Another table gives the annual evaporation in different parts of the world and the total annual evaporation from the earth's entire surface. (Volume 5, p. 223–8.)

Haslam, E.
Measurement of evaporation. Nature, 1885, **32**: 357.

Describes a differential evaporometer in which water flows from a reservoir through an evaporating tank into an overflow receiver. The loss from the reservoir minus the gain in the receiver equals the evaporation from the exposed surface.

Houdailles F.
Études des pluies de 1885. Bul. mét. Hérault, 1885, (—): 41–60.

A comparison of monthly rainfall with the simultaneous evaporation furnishes a factor expressing the relative humidity of each month.

Houdailles F.
Sur les lois d'évaporation. Compt. rend., 1885, **100**: 170–2.

Dalton's formula, $E=B\frac{F-f}{H}$, where E = evaporation from a unit surface in a unit of time, F = the vapor pressure at the surface of the liquid, f = the vapor pressure of the air, H = the atmospheric pressure, and B = a constant determined by the extent of the evaporating surface, is found not to apply to observations with the Piche evaporometer when the wind effect is considered. Confirms Dalton's discovery that evaporation from large evaporating surfaces is proportional to $F-f$. The evaporation in milligrams per hour per square centimeter from a surface of 13 cm² = 1.46 $(F-f)$, but the least agitation of the air alters the relation. Experiments show that an air current with a velocity of 0.25 meter per second raises evaporation from 4.4 to 13.8 milligrams per square centimeter per hour. Develops a formula for the Piche instrument.

Houdailles, F.
Sur l'évaporation dans l'air en mouvement. Comp. rend., 1885, **101**: 428–31.

Shows that the temperature of the Piche atmometer is intermediate between that of the air and that of the wet-bulb thermometer. The rate of evaporation per square centimeter expressed in milligrams per hour, as determined by experiments with temperatures from 6° to 28°C., humidities from 42 to 82 per cent, and an air velocity of 9.0 meters per hour, is exactly given by the relation,

$$P=\frac{62\ (F-f)}{1+0.24\ (F-f)},$$

where P = the evaporation rate and $F-f$ = the difference between the vapor pressure at the water surface and in the free air. Evaporation is greatly influenced by air movement up to a certain velocity, but beyond that it is but slightly affected. Evaporation, P, in a current of air of any velocity will be

$$P=\frac{p}{1+0.5V}+\frac{25.1\ (F-f)}{1+0.24\ (F-f)}\ (V+5\sqrt{V}),$$

where p = the evaporation in quiet air, and V = the wind velocity. A table compares calculated and observed evaporation at different wind velocities.

Jackson, Louis d'Aguilar.
Statistics of hydraulic works and hydrology of England, Canada, Egypt, and India. London. 1885. 8vo.

It is stated, p. 427, that the annual evaporation from Rajputana Tanks for the years 1882–3 was 8.4 feet where exposed to wind, and 4.8 feet where sheltered, the annual rainfall being 2 feet. On p. 455 he states that the amount of evaporation from Vahar Tank, north of Bombay, was 2.5 feet in the eight months of the dry season.

Sprung, A.
Lehrbuch der Meteorologie. Hamburg. 1885.

Discussion (p. 312–13) of the molecular physics of evaporation, and the conditions most favorable for it. In a mathematical discussion of the subject he quotes the formula devised by Weilenmann (1877). Quotes Chapman, 1855, and Ragona, 1867, on the relative evaporation from salt water and fresh water.

Symons, G. J.
Evaporation. Brit. rainf., 1885, (—): 9.

Reports evaporation observations of the Strathfield Turgiss tank continued at Camden Square, where the tank is sunk 1 foot 8 inches in a grass plot. A table of observations accompanies the notice.

Tait, P. G.
On evaporation and condensation. Abstract in Proc. roy. soc. Edinb., 1885, **13**: 91–5.

Discusses the necessity for condensation nuclei.

1886.

Chabaneix, J. B.
Mémoire sur l'évaporation du sol. Bul. mét. Hérault, 1886, (—): 84–94.

Shows that the cultivated soils evaporate less than the natural soils. Different soils present different ratios, varying from 0.75 to 0.48. In this bulletin are given curves of temperature, relative humidity, and daily evaporation. See Chabaneix, 1885, for description of method.

Fitzgerald, Desmond.
Evaporation. Trans. Amer. soc. civ. engin., 1886, **15**: 581–645. Abstracts in Proc. inst. civ. engin., 1887, **88**: 516–7; Sci. Amer. sup., 1886, **21**: 8693–4; Van Nostrand's engin. mag., 1886, **35**: 41–3; Amer. met. jour., 1889, **6**: 7–8. Quoted by Rafter, 1903.

Defines the rate of evaporation as the difference between evaporation and condensation. Other things being equal, the difference between the temperature of the water and that of the dew-point determines evaporation. The principal points to be considered in a study of atmospheric aqueous vapor are: Temperature of the air, dew-point, vapor pressure, absolute and relative humidity, saturation deficit, and the weight of a cubic foot of air at the time of the observation.

Experiments upon the influence of heat on evaporation, E, gave

$$E=0.014\ (V-v)+0.0012\ (V-v)^2,$$

where V = vapor pressure of saturation at temperature of the water surface and v = prevailing vapor pressure of the air. In experiments to determine the influence of wind, the evaporating pans were moved into the open air and anemometers were placed at the level of the water in the pans. The formula for evaporation then becomes, w being the wind velocity in miles per hour:

$$E=[0.014\ (V-v)+0.0012\ (V-v)^2]\ (1+0.67\ w^{\frac{1}{2}}).$$

An approximate formula sufficiently accurate for most purposes is

$$E=\frac{(V-v)\ (1+\frac{1}{2}\ w)}{60}.$$

Concludes with Stelling and Daniell, that ordinary barometric changes are so slight that they can not materially affect the result. A large number of trials show that if observations are taken with sufficient accuracy and frequency very exact results may be obtained by use of the above formula, whether the experiments are conducted in the sun or shade.

Describes an instrument recording continuously air temperature, wind velocity, and evaporation, devised in 1884 and installed at the Chestnut Hill, Mass., reservoir. Records by this and other instruments show that the maximum evaporation does not occur on the hottest days, but may be expected on a cold day preceded by warm weather. Describes evaporation studies at Beacon Hill Reservoir, discusses evaporation in the winter, and reviews the work of Williams, Greaves, Miller, Dines, Latham, Field, Salles, and Wild. Regards measurements of the evaporation from small dishes not immersed in water as not even approximating the losses from a large body of water. (See Bigelow, 1907.)

Harreaux et Gruget.
La pluie et l'évaporation dans la Beauce. Bul. assoc. sci. de France, October 1886, (—): 58. Abstract in Ann. soc. mét., 1887, **35**: 32.

Observations showed that from 1873–1877 the soil evaporation exceeded the rainfall; from 1877–1886 the soil received more water than it lost. Believes that springs are caused by an excess of rain over evaporation, and considers 1000 millimeters the excess necessary to so moisten the lower layers of soil that springs will flow.

Houdaille, F.
Marche comparée de la pluie et de l'évaporation aux divers mois de l'année. Ann. soc. mét., 1886, **34**: 191–2.

The dryness of a climate is expressed by $\frac{P-E}{E}$, in which P = the rain retained in the soil, E = the evaporation from soil and plants during an equal period. These are deduced from the rainfall, P', and the evaporation, E', as indicated by the Piche evaporometer. The monthly values of $\frac{P-E}{E}$ at Montpellier, for the decennial period, 1875–1884, show that the dry period commences in February, is interrupted in April, and finishes in August, the most humid month being January, and the driest July. In order more nearly to approach the value of P the rain intensity was studied with a recording rain gage. Derives a formula for the rate of evaporation from the Piche instrument.

Houdaille, [F.]
Marche annuelle de l'humidité du sol. Bul. mét. Hérault, 1886, (—): 53–64. Pl. 3.

Conclusions: (1) Evaporation from a soil depends on its physical properties, particularly on its clay content, on its faculty of imbibition, and the rate of capillary ascent of water in the dry soil. (2) In a soil possessing a high power of imbibition the variations of humidity at 0.5 meter depth have never exceeded one-fifth of the maximum water content, which has amounted to 19.1 per cent in clayey soil and to 15.9 per cent in less compact calcareous clay soil. (3) The date of minimum soil humidity has not been connected with a certain season, it results at once from the value of evaporation measured in the air and the length of the intervals of time which separate the consecutive rainfalls.

Marié-Davy, F. et H.
Évaporation du sol et des plantes. Jour. agr. prat., 1886, 1: 857-8. Noticed in Forsch. Geb. Agr. Phys., 1888, 10:66.

A brief note on the ratio of percolation to rainfall in case of enclosed masses of soil with and without vegetation. The amount evaporated is derived by subtraction.

Ragona, D.
Sul periodo diurno della evaporazione. Nota. Turin. 1886. 7 p.

Presents tables of precipitation, wind direction and velocity, temperature, and evaporation, observed every two hours in October, 1885, with pentad means. The calculated evaporation shows close agreement with measurements made with a micrometer gage. The calculated curve shows two maxima and two minima, occurring at equal intervals of 6 hours each. The principal maximum falls with the maximum temperature, but the principal minimum lags two to three hours behind the minimum temperature. The author considers that further experiments are necessary before accepting the secondary maximum and minimum.

Ragona, D.
Evaporazione comparata, etc. Ann. met. ital., 1886, parte I. Author's abstract in Met. Zeits., 1889, 6: [31].

The evaporation in Mexico, in the shade, both observed and calculated, is compared with that at Modena. The rate is higher in Mexico from October to April, and lower from May to September. A comparison of the evaporation in the sun for both places shows similar differences in the rates. In both cases the rates for the two regions become equal toward the last of September and the last of April. The ratio between the evaporation in sun and shade was calculated, and a table compares the ratios obtained for Mexico and Modena. The annual curve of this ratio is shown to be identical with that of the relative humidity. The relation of the maximum and minimum to the spring equinox and the solstices is discussed.

Russell, Thomas.
Differences of still and whirled psychrometers. Mo. weather rev., 1886, 14: 299-300.

Emphasizes statistically the need of active ventilation of the wet- and dry-bulb psychrometer.

Shidlovski, F.
Diffusion der Gase and Dämpfe durch poröse Körper. Jour. Russ. phys. chem. soc., 1886, 18(6): 182-204. Abstract in Beibl. Ann. Phys. und Chem., 1887, 11: 618-20.

Discusses the rate of the diffusion of vapor through a porous cylinder.

Symons, G. J.
On the evaporation from a water surface. Brit. rainf., 1886, (-): 14-17.

Describes the method of observing the evaporation from the large tank at Camden Square. A small still-well is made by means of a box, 4 by 4 by 12 inches, having a small hole in the bottom. By means of the hook-gage variations in the level can be read to 0.01 inch.

Teisserenc de Bort, Léon.
Météorologie. Rev. sci., 1886, 36: 528-32.

Teisserenc de Bort, Léon.
L'évaporation. Résumé d'un travail de M. Ragona et des recherches plus récentes de M. Houdaille. Ciel et Terre, 1887, 2: 510-12.

Review of Ragona, 1886, (1st title). Gives Houdaille's formula (see Houdaille, 1885, 3d title).

Venukoff.
Sur la vitesse de desséchement des lacs dans les climats secs. Compt. rend., 1886, 103:1045. Abstract in Ann. soc. mét., 1887, 35:18.

From the statement of the Russian explorer, Nicolski, that the level of Lake Balkash, (area about 19,000 square kilometers), is lowered 1 meter every fourteen or fifteen years, it is calculated that the amount of water annually evaporated must be 1,300,000,000 cubic meters, if none is lost underground. Under the influence of this rapid evaporation the southern part of the lake is gradually being transformed into a deposit of salt, as is also the case with the Caspian Sea, an already dry climate is becoming drier.

1887.

Chabaneix, J. B.
Mémoire sur l'évaporation du sol. Bul. mét. Hérault, 1887.

Continued from 1886.

Davis, W. M.
Water vapor and radiation. Amer. met. jour., 1887, 3:443-4.

Discusses relation between size and speed of evaporation of water particles floating in the air.

de Touchimbert.
Observations météorologique faites à Poitiers en octobre et novembre, 1886. Ann. soc. mét., 1887, 35:46.

The evaporation for October was 33 millimeters, for November, 26 millimeters.

Denza, P. Francesco.
Meteorologia Elementare di Roberto H. Scott. (Translation). Milan. 1887.

See Scott, 1887.

Harreaux.
Observations hydrométriques de la Beauce. Ann. soc. mét., 1887, 35:242-7.

Compares the rates of evaporation from various surfaces under different exposures. Observations for the first three years showed an excess of evaporation equal to the cube of the rainfall for the same period; in 1876 rainfall and evaporation were equal; in the following years the rainfall exceeded the evaporation, and the levels of wells and streams rose accordingly. (See Harreaux et Gruget, 1886.)

Hauvel, Charles.
Du rôle de la vapeur d'eau dans l'atmosphère. Ann. soc. mét., 1887, 35:6-7, 9-15.

Study of evaporation as influenced by the "atmospheric tide."

Hépites, S. C.
Evaporation de l'eau. Ann. inst. mét., Roumania, 1887, 3:124-7.

Daily records of evaporation by Wild's recording evaporometer show two maxima for the year, 3.3 millimeters on May 21 and 3.1 millimeters on September 24. The total annual evaporation was 325.5 millimeters. Other tables show the monthly, seasonal, diurnal, and nocturnal rates. The ratio of the nocturnal to the diurnal rate was 3.53 in 1886 and 3.41 in 1887.

Klein, Hermann J.
Allgemeine Witterungskunde. Leipsic, Vienna, and Prague. 1887. p. 78-80.

General discussion of the laws and the methods of measuring evaporation.

Legras.
Sur un évaporomètre à température regulier. (Résumé par M. Teisserenc de Bort). Ann. soc. mét. 1887, 35:241-2.

This atmometer is similar to the rain gages issued by the royal Belgian observatory to its meteorological stations. It consists of an evaporating dish set into a much larger vessel, also containg water, and designed to reproduce the temperature and hygrometric conditions of a natural stream. Gives the evaporation for May, June, July, October, and November, 1886, as 59.6, 34.2, 34 7, 28.3, and 21.8 millimeters, respectively.

Milani, Gustavo.
Meteorologia popolare. Florence. 1887. p. 90-2.

Short discussion of the process and importance of evaporation.

Mohn, H.
Grundzüge der Meteorologie. Berlin. 1887. 4th ed.

See Mohn, 1875.

Murray, John
Rainfall and evaporation on the land surfaces of the globe. Abstracts in Scot. geog. mag., 1887, 3:65-77; Met. Zeits., 1887, 4:63; Forsch. Geb. Agr. Phys., 1888, 10:457-9.

Evaporation is computed from the run-off and rainfall in different latitudes of the earth's surface, as follows:

Latitude.	Evaporation.	Rainfall.
°	*Mm.*	*Mm.*
50-60 N.	365	555
40-50 N.	510	745
30-40 N.	835	955
20-30 N.	805	940
10-20 N.	885	1,430
10 N.-10 S.	1,375	1,775
20-40 S.	951	1,225
Mean...	965	1,240

These are amounts of evaporation as related to temperature, humidity, and rainfall, while rainfall does not enter as a factor in the record of an evaporometer which shows only what would evaporate with a constant water supply. Estimates that not less than 87,000 cubic kilometers of water evaporate annually from the land surface of the globe.

Peek, Cuthbert E.
Evaporation experiments at Rousden Observatory, Devon, England. Amer. met. jour., 1887, 4:2-3. Abstract in Quart. jour. roy. met. soc., 1887, 13:242-3.

The evaporation from soil with turf and from water was measured by means of two similar tanks, 24 x 24 x 15 inches, freely exposed to the air, but protected from the sun's rays by a louvred wooden screen. The total annual evaporation from the soil was 24.79 inches, and from the water 22.81 inches.

Ritter, Charles.
Actions élémentaires dont dépend la croissance des nebules et des hydrométéorites. Ann. soc. mét., 1887, 35:361-432.

History of earlier views of the formation of atmospheric vapor and discussion of the same from the modern point of view.

Scott, R[obert] H.
Elementary Meteorology. London. 1887. 4th ed. p. 95-103. (Translated by P. F. Denza, 1887. q. v.)

The process, effects, and importance of evaporation are discussed. The rainfall and evaporation on the earth's surface are believed to nearly balance each other.

Symons, G. J.
The Camden Square evaporation experiments. Brit. rainf., 1887, (—):38-9.

Results of measurements at the tank at Camden Square for 1887 and to June, 1888.

Warington, R.
A contribution to the study of well waters. Jour. chem. soc., 1887, 51:52.

Considers the effect of vegetation in increasing evaporation from the soil.

Woeikof, Alexander.
Klimate der Erde. Jena. 1887. 2 vols.

Estimates annual evaporation from the Caspian Sea as 1090 millimeters. (Vol. 2, p. 265.)

Wollny, E.
Forstlich-meteorologische Beobachtungen. Forsch. Geb. Agr. Phys., 1887, 10:415-46. Abstracts in Exp. sta. rec., 1895, 6:197-9; Met. Zeits., 1896, 13:362-4; also by Abbe, 1895.

An investigation of the rates of evaporation from different soil mulches. Conclusions: (1) The soil evaporates more water than the various mulches. (2) Of all the mulches experimented with, moss evaporates most, then follow oak leaves, beech leaves, fir and pine needles, with but small differences. (3) The thinner the mulch the greater the evaporation. (Continued in 1890.)

1888.

Abbe, Cleveland.
Treatise on meteorological apparatus and methods. Ann. Rpt. Chief Signal Officer for 1887, Pt. 2 (App. 46). Washington. 1888.

Discusses methods of measuring evaporation and of the temperature and rate of the same in connection with the hygrometric conditions of the air. Reviews work on vapor pressure and latent heat of vaporization by Ivory, Apjohn, Regnault, Glaisher, Kämtz, Wüllner, Stefan, Maxwell, Chistoni, Doyère, Angot, Sworykin, Pernter, and Ferrel. The observations by Fitzgerald and the formula derived by him are presented in detail.

Chabaneix, J. B.
Mémoire sur l'évaporation du sol. Bul. met. Hérault, 1888.

Continued from 1886 and 1887.

Greeley, A. W.
American Weather. New York. 1888. 8vo.

General discussion (p. 45–48) of the various classes of evaporometers.

Hann, J.
Beobachtungen über Verdunstung in der Kolonie New South Wales. Met. Zeits, 1888, 5:323.

Summarizes the results of observations of evaporation in New South Wales made by H. C. Russell in 1885. (See Symons, 1890.)

Müller-Erzbach, W.
Die Bestimmung der Durchschnittstemperatur durch das Gewicht von verdampfter Flüssigkeit. Met. Zeits., 1888, 5:453–9.

Determines the average temperature of the air by measuring the loss in weight through evaporation of various liquids. The results agree closely with the means of thermometer readings.

Russell, T[homas].
Depth of evaporation in the United States. Mo. weather rev., 1888, 16:235–9.

The evaporation from the Piche evaporometer was compared with that from a free water surface in a small dish, both dish and Piche being exposed in the standard louvred shelter of that date. The depth of evaporation recorded by the Piche and the average wind velocity at 19 different stations during June to September, 1888, are tabulated. Also determines the relative amounts lost by evaporation from stationary and whirling Piche for velocities of 10, 15, 20, 25, and 30 miles per hour. The rate of evaporation at Signal Service stations is then computed from the means of the tridaily readings of the wet-bulb and dew-point for the period December, 1887, to January, 1888, inclusive, using the following formula (no wind term is used because of the shelter exposure):

$$30\left(\frac{Ap_w+B(p_w-p_d)}{b}\right),$$

in which p_w=the vapor pressure for the mean monthly temperature of the wet-bulb thermometer, p_d=vapor pressure for the monthly mean dew-point, b=mean barometric pressure, A=1.96, and B=43.9. He compares these computed values with those observed at the Boston waterworks by Fitzgerald; and by means of them constructs a chart of lines of equal annual depth of evaporation at the U. S. Signal Service stations for the period July, 1887, to June, 1888.

Symons, G. J.
The Camden Square evaporation experiments. Brit. Rainf., 1888, (—): 42–3.

Tables of evaporation from the large tank at Camden Square from July, 1888, to June, 1889, inclusive.

1889.

Campidoglio, R. Osservatorio del.
Osservazioni meteorologiche del R. Osservatorio del Campidoglio. Atti r. accad. Lincei, 1889, 5: (4).

The daily evaporation in millimeters and the monthly totals from January to July, 1889, show variations from 54.33 millimeters in February to 149.40 millimeters in July.

Carpenter, L. G.
Evaporation from tanks placed in the ground and also from tanks floating in the water. Colo. exp. sta. 2d Ann. Rpt., 1889, p. 49–76. Abstract in Exp. sta. rec., 1890, 2:394.

A table presents the monthly evaporation for the years 1887–9 at Fort Collins, Colo., from tanks 3 by 3 by 3 feet and also from smaller tanks to determine the influence of size and material on evaporation. The evaporation computed from the following expression differed only slightly from the observed amount: Evaporation in inches for 12 hours = $0.1934\,(T-t)(1+0.005\,w)$, in which T is the vapor pressure at the temperature of the water surface, t the vapor pressure of the air, and w the velocity of the wind in miles per 12 hours. For a whole day the formula becomes, $E=0.3868\,(T-t)(1+0.0025\,w)$. Fitzgerald's formula is quoted: E (24 hours) $=0.3984\,(T-t)(1+0.0208\,w)$. The close agreement of these coefficients, derived from investigations carried on under as different circumstances as these, strengthens confidence in either formula, and makes it probable that the true value of the coefficient is not far from 0.39 or 0.40. (See Bigelow, 1907.)

Davis, Walter G.
Ligeros apuntes sobre el clima de la República Argentina. Buenos Aires. 1889. p. 238–40.

Tables of evaporation from water in sun and shade, for the years 1886–1888, inclusive show an annual average of 2292.7 millimeters in the sun and 1169.6 millimeters in the shade. Comparative experiments on evaporation from a copper dish, a glass dish, and a Wild balance, gave in the sun 1320.7 millimeters for the first, 1088.5 millimeters for the second, and 1252.2 millimeters for the last; in the shade 648.8 millimeters for the first, and 624.1 millimeters for the last.

Demangeon, A.
Climatologie d'Épinal (Vosges). Résumé général pour 10 ans, de 1872 à 1881, des observations météorologiques faites à Épinal. Épinal. 1884. 2iéme. tirage, 1889.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	Mm.	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*
Rainf..	119.2	70.0	75.1	75.0	72.4	89.9	108.6	94.9	78.8	98.9	82.9	68.4	964.0
Vap. pr	4.83	5.19	5.86	6.45	7.52	10.52	12.09	11.75	9.56	7.33	5.84	4.94	7.68

This lithographed sheet, 10 by 16 inches, presents a table of monthly and annual means of all the meteorological elements, including observations with a psychrometer and a Piche evaporometer, extracted from the "Résumé général detaillé" published by the same author. The mean monthly and annual rainfall and vapor pressures at Épinal for the period 1872–81 are shown in the above table.
The evaporation is here omitted since the table gives no denomination for its figures.

[*To be continued.*]

METEOROLOGY IN THE SCHOOLS.

THE USE OF LANTERN SLIDES.

Many Weather Bureau officials are finding that more and more of their attention must be devoted to the educational calls being made upon them by the schools and the public generally. The writer knows of at least two who have already made quite a collection of lantern slides illustrating the lectures which they are frequently called upon to deliver. Probably a larger number have also made such collections. It will, therefore, be of interest to all such to read a very suggestive and instructive article by Prof. W. H. Hobbs[1] of the University of Michigan, wherein is described his method of classifying and storing lantern slides. The method used makes the course of lectures the primary base in the classification of the collection of slides. The slides are stored in unit boxes of japanned tin 3½ by 4 inches on the bottom and 3 inches deep, divided into front and rear halves by a tin partition. Each box holds sixteen slides in one half, the other half being reserved to receive the slides as they are removed from the lantern; and a box is expected to accommodate the slides illustrating a subdivision of a general topic, indicated by labels on the end of the box. Besides the slides these boxes also receive properly trimmed cards on which are entered lecture data, references to literature, etc., such as pertain to the subject of the slides in the same box; thus the lecturer has ready at hand both the illustrations and the references for the subjects on which he is lecturing.

THE WEATHER MAP AND THE SCHOOLS.

California is one of the States in the Union that takes the liveliest interest in the study and teaching and application of meteorology and climatology. Recent numbers of the Bulletin of the California Physical Geography Club bear witness to this interest and its practical expression. The number for March, 1909, contains descriptions of the courses at the San Rafael and San José high schools.

Mr. Percy E. Rowell, the instructor at the San Rafael High School, has perfected a very effective system of individual home observation and study in connection with the regular class work in the school. Each student procures a moderately accurate but cheap thermometer (price 25 cents) which he exposes "on the outside of the house toward the north." These individual thermometers are read daily and reported on, and "much interest has been aroused by the voluntary comparisons of weekly averages of temperature, and a little local pride has been stimulated in regard to places of greatest heat or least heat in winter and summer, respectively." The well equipped school observatory is in charge of a pair of pupils each week who make three observations daily, including Saturday, Sunday, and other holidays, compile the weekly record and publish a summary in a local newspaper over their own names. The whole class follow this work, keeping their records on appropriate forms and rendering duplicates to the teacher, who very properly emphasizes the fact that this routine work compels the pupil to attend to business, to *think of his work* even when he is not at school and studying. "It humanizes the science and makes it knowledge, not memory."

The San José High School also has a well equipped laboratory for physical geography. The present instructor, Miss Elizabeth McFadden, writes, "Our interest at present, in common with the general public, is in the weather. I constantly

[1] W. H. Hobbs: The use of lantern views with science lectures. The Journal of Geography, April, 1909, 7:180-6.